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الشيخ

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Properties of DFT

① Periodic Property

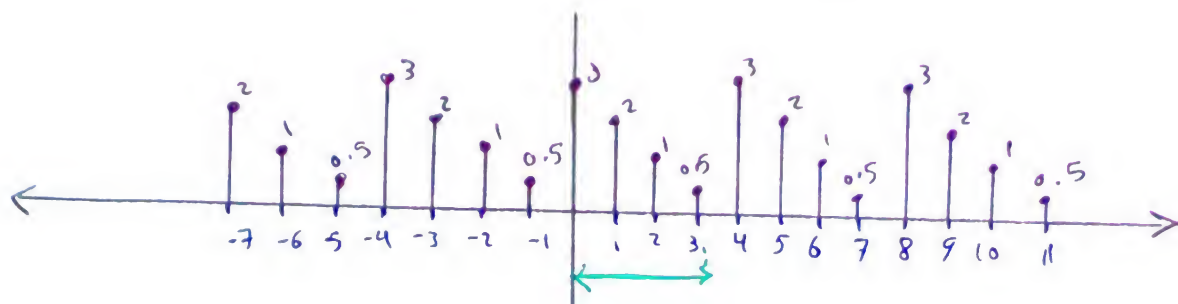
$$X(K) = X(K+N)$$

② Linearity

$$X_1(n) + X_2(n) \Rightarrow X_1(K) + X_2(K)$$

③ Circular Shift

$$x(n) = \{3, 2, 1, 0.5\}$$



$$x((n-1))_4 = \{0.5, 3, 2, 1\} \quad ; \quad x((n+1))_4 = \{2, 1, 0.5, 3\}$$

$$x((-n))_4 = \{3, 0.5, 1, 2\}$$

Example: - $x(n) = \{1, 2, -1, 3, \frac{1}{2}\}$

Find:

$$x((-n))_5 \Rightarrow \{1, \frac{1}{2}, 3, -1, 2\}$$

$$x((2-n))_5 \Rightarrow \{-1, 2, 1, \frac{1}{2}, 3\}$$

$$x((-2-n))_5 \Rightarrow \{3, -1, 2, 1, \frac{1}{2}\}$$

$$x((n-2))_5 \Rightarrow \{3, \frac{1}{2}, 1, 2, -1\}$$

$$x((n+2))_5 \Rightarrow \{-1, 3, \frac{1}{2}, 1, 2\}$$

Circular Convolution:-

$$y(n) = X_1(n) \otimes X_2(n) = \sum_{m=0}^{N-1} X_1(m) X_2((n-m))_N$$

$$X_1(n) = \{1, 2, 0, 1\}$$

$$X_2(n) = \{2, 2, 1, 1\}$$

$$y(n) = \begin{pmatrix} 2 & 1 & 1 & 2 \\ 2 & 2 & 1 & 1 \\ 1 & 2 & 2 & 1 \\ 1 & 1 & 2 & 2 \end{pmatrix} \begin{pmatrix} 1 \\ 2 \\ 0 \\ 1 \end{pmatrix} = \begin{pmatrix} 6 \\ 7 \\ 6 \\ 5 \end{pmatrix}$$

Another method

$$\begin{array}{rcccc} & & 1 & 0 & 2 & 1 \\ & & 1 & 1 & 2 & 2 \\ \hline & & 2 & 0 & 4 & 2 \\ & & 0 & 4 & 2 & 2 \\ & & 2 & 1 & 1 & 0 \\ & & 1 & 1 & 0 & 2 \\ \hline & & 5 & 6 & 7 & 6 \end{array}$$

Microcontroller VS. DSP

$$X(K) = \sum_{n=0}^{N-1} x(n) \omega_N^{Kn}$$

$$\omega_N^{K+N} = \omega_N^K$$

$$\omega_N^{K+N/2} = -\omega_N^K$$

$$\omega_N^2 = \omega_{N/2}$$

$$\sum_{n=\text{even}} x(n) \omega_N^K + \sum_{n=\text{odd}} x(n) \omega_N^K$$

$$\sum_{n=0}^{N/2-1} x(2n) \omega_N^{2Kn} + \sum_{n=0}^{N/2-1} x(2n+1) \omega_N^{2Kn} \quad \omega_N^K \rightarrow \text{constant}$$